DOCUMENT RESUME

ED 270 086 IR 012 099

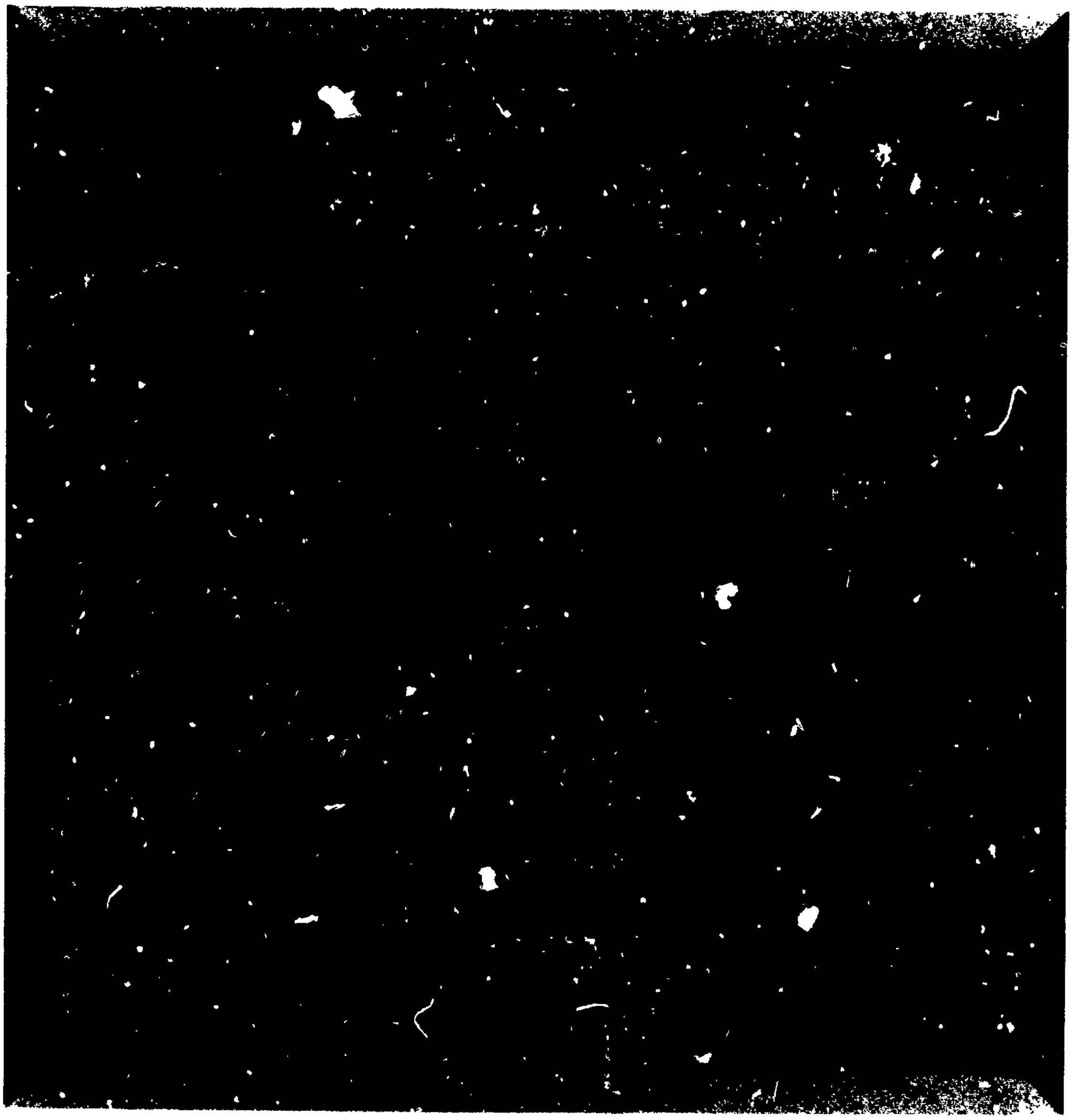
AUTHOR	Holmstrom, Engin Inel
TITLE	Access to Supercomputers. Higher Education Panel Report 69.
INSTITUTION	American Council on Education, Washington, D.C. Higher Education Panel.
SPONS AGENCY	Department of Education, Washington, DC.; National Endowment for the Humanities (NFAH), Washington, D.C.; National Science Foundation, Washington, D.C.
PUB DATE	Jan 86
CONTRACT	SRS-8117037
NOTE	33p.
PUB TYPE	Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*College Faculty; *Computers; Higher Education; National Surveys; Questionnaires; *Researchers; Research Methodology; *Research Universities; Tables (Data); Technological Advancement; Universities; *Use Studies
IDENTIFIERS	*Supercomputers

ABSTRACT

This survey was conducted to provide the National Science Foundation with baseline information on current computer use in the nation's major research universities, including the actual and potential use of supercomputers. Questionnaires were sent to 207 doctorate-granting institutions; after follow-ups, 167 institutions (91% of the institutions meeting survey criteria) responded with at least one departmental questionnaire completed. Non-response adjustment weights were used to calculate national estimates. Based on these weighted responses, the study describes computer-use practices of about 33,500 faculty and professional research staff employed in about 1,190 departments in 185 universities in the United States. Findings indicate: (1) only about one in 20 faculty and research staff have used supercomputers in their research; (2) the most frequent use of supercomputers has been in atmospheric sciences--over 20% of the researchers in this field had used supercomputers in their research; (3) over 80% of the 1,190 departments surveyed in 10 science-related fields reported limited access to supercomputers; (4) departments that ranked in the top 50 according to research and development expenditures had more ready access to supercomputers (25%) than departments at other institutions (14%); and (5) access to time on supercomputers was ranked first among the types of assistance needed to increase their use. Nine data tables, the study questionnaire, and a summary of the research methods are provided. (JB)

ACCESS TO SUPERCOMPUTERS

Engin Inel Holmstrom



HIGHER EDUCATION PANEL REPORT NUMBER 69
AMERICAN COUNCIL ON EDUCATION

JANUARY
1986

A Survey Funded by the National Science Foundation, the U S Department of Education, and the National Endowment for the Humanities

AMERICAN COUNCIL ON EDUCATION

Robert H. Atwell, President

The American Council on Education, founded in 1918, is a council of educational organizations and institutions. Its purpose is to advance education and educational methods through comprehensive voluntary and cooperative action on the part of American educational associations, organizations, and institutions

The Higher Education Panel is a survey research program established by the Council for the purpose of securing policy-related information quickly from representative samples of colleges and universities *Higher Education Panel Reports* are designed to expedite communication of the Panel's survey findings to policy-makers in government, in the associations, and in educational institutions across the nation.

The Higher Education Panel's surveys on behalf of the Federal Government are conducted under support provided jointly by the National Science Foundation, The National Endowment for the Humanities, and the U.S. Department of Education (NSF Contract SRS-8117037)

STAFF OF THE HIGHER EDUCATION PANEL

Engin Inel Holmstrom, *Panel Director*

Charles J Andersen, *Assistant Director*

Clare McManus, *Research Assistant*

Bernard R Greene, *Research Analyst/Programmer*

Shirley B Kahan, *Staff Assistant*

HEP ADVISORY COMMITTEE

Elaine El-Khawas, *Vice President* for Policy Analysis and Research, ACE, *Chair*

Jules B LaPidus, *President*, Council of Graduate Schools in the United States

Robert M. Rosenzweig, *President*, Association of American Universities

James Hyatt, Director of the Financial Management Center, National Association of College and University Business Officers

Connie Sutton-Odems, *Vice President* for Professional Services, American Association of Community and Junior Colleges

FEDERAL ADVISORY BOARD

William Stewart, National Science Foundation, *Chairman*

Jeffrey D Thomas, National Endowment for the Humanities

Salvatore Corrallo, U S Department of Education

Christina Wise, National Science Foundation, *Secretary*

TECHNICAL ADVISORY COMMITTEE TO THE FEDERAL ADVISORY BOARD

Martin Frankel, National Center for Education Statistics, *Chairman*

Nancy M. Conlon, National Science Foundation

Jeffrey D Thomas, National Endowment for the Humanities

Additional copies of this report are available from the Higher Education Panel, American Council on Education, One Dupont Circle, Washington, D C 20036

ACCESS TO SUPERCOMPUTERS

Engin Inel Holmstrom

Higher Education Panel Reports
Number 69 January 1986

American Council on Education
Washington, D.C. 20036

This material is based upon research supported jointly by the National Science Foundation, the U.S. Department of Education, and the National Endowment for the Humanities under contract No. SRS-8117037 with the National Science Foundation. Any opinions, findings, conclusions, or recommendations are those of the authors and do not necessarily reflect the views of the sponsoring agencies.

TABLE OF CONTENTS

ACKNOWLEDGMENTS

This stu y was sponsored by the National Science Foundation (NSF) and is the last in the series of federally-supported surveys conducted by the Higher Education Panel since 1971. We are grateful to the National Science Foundation, National Institutes of Health, National Endowment for the Humanities, and the U.S. Department of Education for their support of the Panel studies over the past fourteen years. Our thanks go to the staff of the above-mentioned federal agencies, the Federal Advisory Board, and its Technical Advisory Committee for their advice and contributions over the years.

We are grateful to Mary Golladay and Christina Wise of NSF for their contributions to the present study and to the American Council on Education's Higher Education Panel's Advisory Committee for their guidance and suggestions. As usual, we offer special recognition and thanks to each campus representative and departmental respondent for their cooperation and timely response to the study.

Finally, we wish to acknowledge that the early stages of this study were conducted under the guidance of Frank J. Atelsek, the Higher Education Panel's Director, until his untimely death in May 1985.

LIST OF DETAILED STATISTICAL TABLES

Page

HIGHLIGHTS

Over 80 percent of the 1,190 departments surveyed in 10 selected fields (that is, electrical, mechanical, and metallurgical/materials engineering; atmospheric and geosciences; cell biology; mathematics/applied mathematics; chemistry; physics; and economics) reported limited access to supercomputers.

The most frequent use of supercomputers was in atmospheric sciences where a majority of departments had ready access to supercomputers. Over 20 percent of researchers in atmospheric sciences currently use, or have used, supercomputers in their lines of research.

The use of supercomputers in most other fields is limited to about 1 in 20 faculty and professional research staff.

In general, departments at institutions ranked in the top 50 according to research and development expenditures had more ready access to supercomputers (25 percent) than departments at other institutions (14 percent).

The limited capacity and speed of conventional main frame computers is constraining the research activity of about one-eighth of the faculty and research staff in the disciplines and universities surveyed.

The sequential processing design of conventional computers, as opposed to the parallel processing capabilities of supercomputers, is constraining the research activity of about one-tenth of the faculty and research staff.

In general, access to time on supercomputers was the first-ranked type of assistance needed to increase their use. The other types of assistance often ranked first were (a) opportunities to gain knowledge about the technical capabilities of supercomputers and (b) access through telecommunication links to remote centers with supercomputers.

BACKGROUND

A lot of attention has been paid by the media recently to the fact that the use of microcomputers has become relatively widespread at the nation's colleges and universities. A less publicized fact is that a vast majority of researchers at academic institutions have no access to advanced large scale computers, or "supercomputers" as they are referred to in the popular media. Supercomputers such as **Cray-1**, first introduced in 1977, and **Cyber 205**, introduced in 1981, perform at least 100 million floating point operations per second and are recognized as one of the most important research, development, and design tools of the late 20th century.[1]

Supercomputers offer the potential for advances in research activity in a wide range of fields and permit researchers to pursue lines of inquiry not feasible with conventional main frame machines such as those in the IBM-308x series, VAX-7XX series, or CDC-7600. Supercomputers have already revolutionized various industries, including the petroleum industry, the aircraft industry, the automotive industry, the electronics industry, the electric-power industry, and the movie industry. Many argue that the lack of access to supercomputers for most researchers on American universities is going to have serious long-term consequences for the nation, and that without supercomputers, American basic research and engineering science will fall behind that of other countries which are pursuing aggressive national policies regarding the availability and use of supercomputers.[2]

The National Science Foundation (NSF) has been concerned with the problem of inadequate access to supercomputers for university researchers, and in 1983 issued a planning report entitled "A National Computing Environment for Academic Research," known as the Bardon report. The report outlined a tentative two-step plan to increase access to supercomputers. However, the Foundation had only limited information on which to decide relative priorities for action.[3]

Because supercomputers cost considerably more than conventional main frame machines, it is unlikely that in the near future most large universities can expect to acquire supercomputers for use on their campuses. Shared facilities and networks appear to be more viable options. Further, supercomputers are fundamentally different from conventional computers and require different conceptualization and presentation of problems. To increase the research applications of supercomputers, information is needed on the need and mechanisms for supplying machine time, information-networks, and technical support.

This study was sponsored by NSF to provide the Foundation with benchmark information on current computer use in the nation's major research universities, including the actual and potential use of supercomputers. The survey was conducted by the Higher Education Panel of the American Council on Education (ACE). (See Appendix B: Methods Summary for technical details.)

The survey universe was designed to include all major research universities that award five or more doctoral degrees and have a doctorate-granting department in at least one of the following fields: electrical engineering, mechanical engineering, metallurgical/materials engineering, atmospheric sciences, geosciences, cell biology, mathematics and applied mathematics (computer science), chemistry, physics, and economics.

Questionnaires were mailed in mid-April 1985 to 207 doctorate-granting Panel members. Twenty-three reported that they did not meet the survey criteria; this reduced to 184 the number of institutions from which substantive responses could be expected.[4] After followups, 167 institutions (91 percent) responded with at least one departmental questionnaire completed. The survey responses were weighted using non-response adjustment weights to calculate national estimates. Based on these weighted responses, the study describes computer-use practices of about 33,500 faculty and professional research staff employed in about 1,190 departments located in 185 doctorate-granting universities in the nation (see table B-3 in Appendix B). Faculty who were away from campus on sabbatical in spring of 1985 and graduate students participating in research projects, whether salaried or on other support, were not included in the study.

Findings are presented by departments, by control of institutions, and by top 50 status of institutions in terms of research and development (R&D) expenditures during 1980-83. Two-thirds of the departments were in public and one-third in private institutions. Just over 70 percent of the faculty and research staff were in public institutions. About one-third of the programs were housed in the top 50 institutions, which employed 45 percent of the faculty and research staff.

1. Gene Dallaire, "American Universities Need Greater Access to Supercomputers." Communications of the ACM. April 1984, Vol.27, No.4, 292-298.

2. Ibid.

3. "Access to Supercomputers An NSF Perspective, An Interview with Edward F. Hayes," Communications of the ACM, April 1984, Vol. 27, No. 4, 299-303.

4. National Center for Education Statistics' data and other listings indicate that 185 institutions (only one not a member of the Panel) met the study eligibility criteria.

FINDINGS

The findings are presented in two major sections. First, current use of computers and scientific work stations, applicability of supercomputers to present lines of research, and the type of assistance needed to increase university researchers' access to supercomputers are discussed in general terms. Then departmental summaries are presented.

General Findings

Present Use of Computers

Respondents were asked to indicate how many of their full-time faculty and research staff were (a) currently using or have used supercomputers, (b) were formulating plans for research requiring supercomputers, or taking concrete steps to pursue an interest in them, (c) now using conventional main frame computers as an integral part of their research, and (d) now making no use of conventional main frame computers. They were asked to account for each person only once in the list and treat the list as hierarchical. Therefore, the number of faculty reported below as making use of conventional main frame computers may be an underestimate insofar as some of the faculty and research staff using or making plans to use supercomputers may also be using conventional main frame machines in their current lines of research.

Currently only about 1 in 20 faculty and professional research staff in the selected fields surveyed use, or have used, supercomputers in their research. Another 1 in 20 appear to be formulating plans for research which will require the use of supercomputers. Thus, when these plans materialize, about 1 in 10 university researchers may be making use of supercomputers in their lines of research. In addition, over 4 in 10 faculty and professional staff use conventional main frame computers, such as IBM, VAX or CDC-7600. Another 4 in 10 are currently making no use of conventional main frame machines.

Combining users of both supercomputers and conventional main frame computers, it appears that just over half the faculty and professional research staff at doctoral departments in ten selected fields use computers in their lines of research, and the utilization patterns are surprisingly similar across faculty employed in public (55 percent) or private (56 percent) universities (see figure 1). However, those employed in the top 50 institutions are slightly more likely to use computers (58 percent) than are faculty employed in other institutions (53 percent) (see figure 2).

Although institutional characteristics (that is, control and top 50 status) do not appear to be strongly related to the pattern of computer use of university researchers, there are substantial departmental differences (see figure 3). The heaviest total computer use is in atmospheric sciences where 78 percent of the faculty and professional research staff use computers, followed by electrical engineering (73 percent), mechanical engineering (72 percent, and physics (67 percent). The least use of computers is in departments of mathematics/applied mathematics and cell biology (each 39 percent).

The heaviest use of supercomputers is among the faculty and professional research staff employed in departments of atmospheric sciences, where over 2 in 10 use supercomputers in their lines of research. Further, if the current research plans of about 10 percent of the faculty in such departments materialize, then over 3 in 10 atmospheric sciences faculty and professional staff would be using supercomputers regularly in their lines of research.

Similarly, if current research plans of faculty in mechanical engineering and physics materialize, in each field nearly 2 in 10 faculty would be using supercomputers in their lines of research. In other fields, the actual and potential use of supercomputers varies from over 1 in 10 faculty (electrical engineering, metallurgical and materials engineering, geosciences) to about 3 percent of faculty in economics.

Current use of supercomputers is, of course, dependent on the degree with which supercomputers are accessible to faculty and research staff in each field. Over 80 percent of faculty and research

Figure 1 - Computer Use by Faculty/Research Staff at Doctoral Departments, by Control of Institution

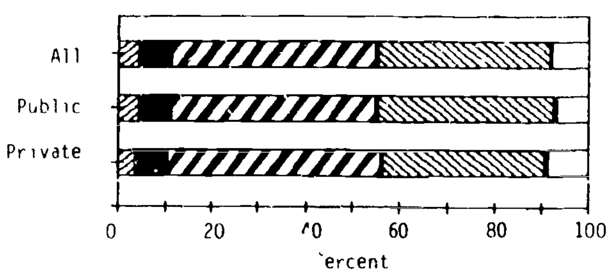
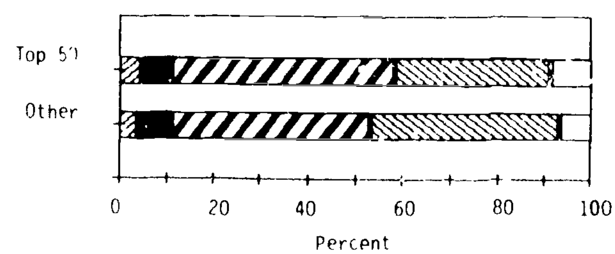


Figure 2 - Computer Use by Faculty/Research Staff at Doctoral Departments, by Top 50 (R&D) Status



Using supercomputers | Planning to use supercomputers | Using conventional computers | Currently not using any computer | Computer use unknown

Figure 3 Level of Computer Use by Total Faculty/Research Staff at Doctoral Departments

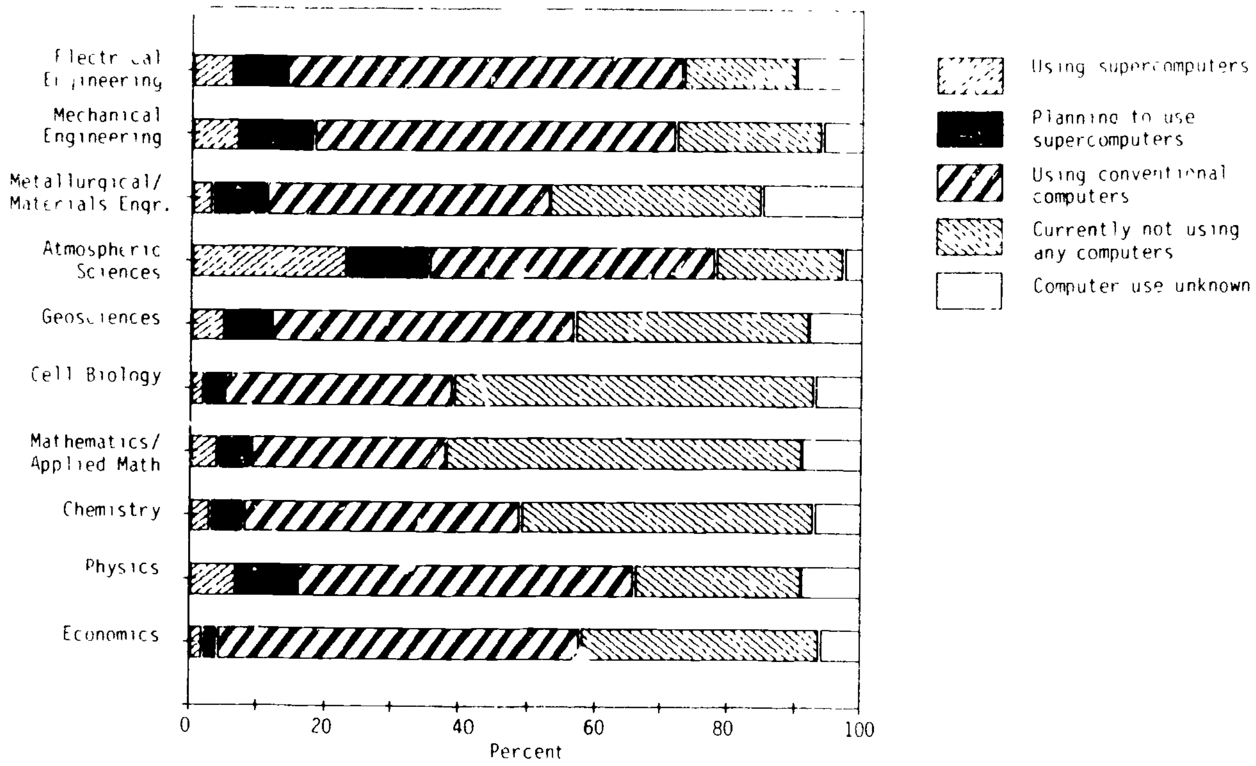
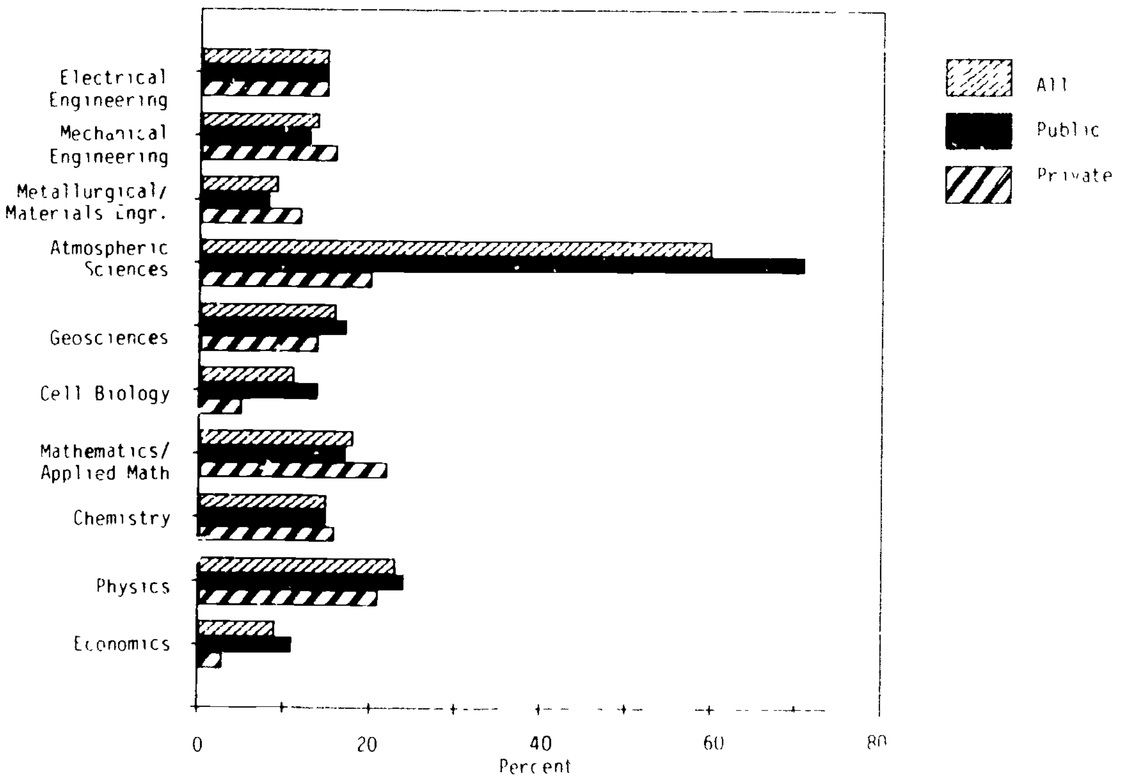


Figure 4 - Proportion of Doctoral Departments with Ready Access to Supercomputers, by Control of Institution



12

staff seem to have only limited access to supercomputers. Not surprisingly, 60 percent of departments of atmospheric sciences, where supercomputer use is most frequent, reported that their faculty and professional research staff have ready access to supercomputers (see figure 4). In contrast, the proportion of remaining departments with ready access to supercomputers varied from a high of 23 percent (physics) to a low of 9 percent (metallurgical/materials engineering and economics).

In general, departments in public and private institutions seem to provide similar rates of ready access to supercomputers. The only exception is in atmospheric sciences where 71 percent of departments located in public but only 20 percent of those located in private institutions had ready access to supercomputers. Finally, supercomputers are more readily accessible in departments located in the top 50 institutions than those located in other institutions (see figure 5).

One-fifth (22 percent) of the departments with limited access to supercomputers stated that gaining ready access to the machines was a matter of high priority. Opinion varied by discipline, however. Figure 6 shows that nearly half of the atmospheric sciences departments that had limited access and over one-third of such mechanical engineering and physics departments gave high priority to gaining ready access to supercomputers. However, only 5 percent of the economics departments and 6 percent of the cell biology departments that had only limited access gave gaining ready access a high priority.

Use of Scientific Work Stations

For the purposes of this study, scientific work stations were defined as 32-bit machines with memory of at least one megabyte; screen resolution on the order of 800x1,000 in order to adequately display a full range of graphics, and the ability to work in an integrated network environment with UNIX-like operating system and a Fortran compiler. Excluded were personal computers used as word processors and word processors with business graphics capabilities.

The use of scientific work stations ranged from one-fourth of faculty in departments of electrical engineering, atmospheric sciences, and geosciences to about 10 percent of faculty in departments of cell biology, mathematics/applied mathematics, and chemistry (see detailed table 6).

There was no consistent difference in the use of scientific work stations by faculty and research staff employed in public and private institutions. In metallurgical/materials engineering and atmospheric sciences, more of the faculty and research staff in public than in private institutions used scientific work stations while the reverse was true for those in chemistry and mathematics/applied mathematics. Surprisingly, faculty and research staff employed in the top 50 institutions were somewhat less likely to use scientific work stations than were faculty employed in other insti-

Figure 5 - Proportion of Doctoral Departments with Ready Access to Supercomputers, by Top 50 (R&D) Status of Institution

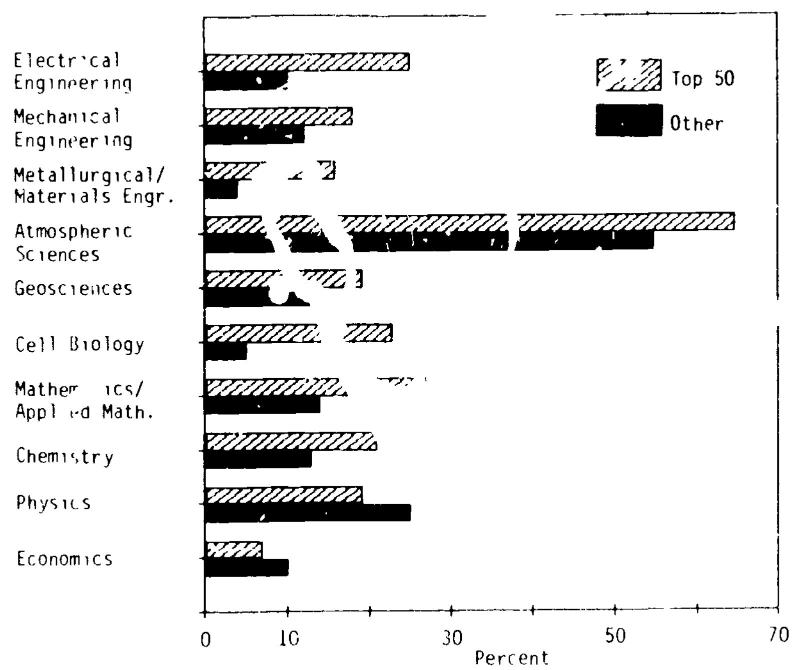
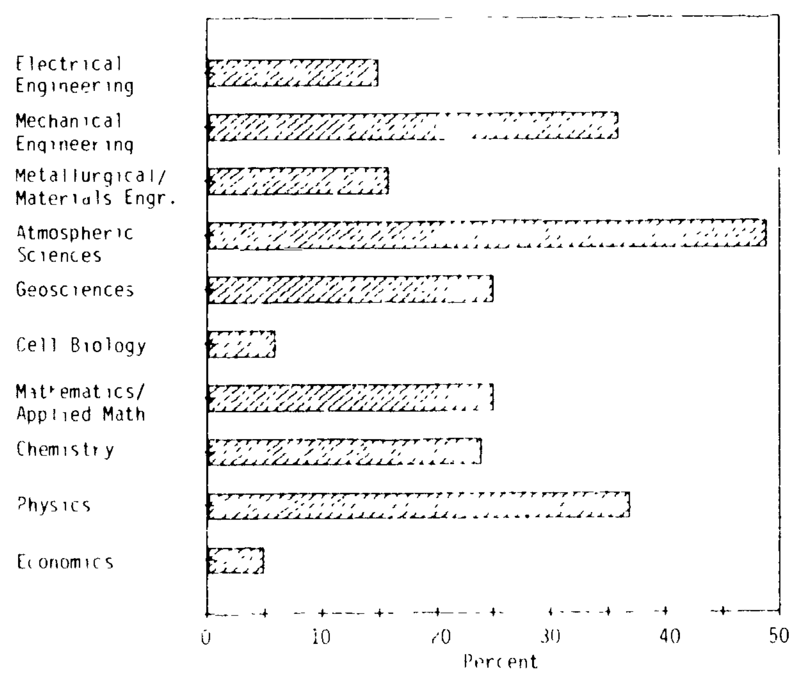


Figure 6 - Proportion of Doctoral Departments with Limited Access to Supercomputers That Place a High Priority on Gaining Access



tutions (see detailed table 5.2). Finally, faculty and research staff in departments with ready access to supercomputers were more likely to use scientific work stations than faculty in departments with limited access to supercomputers (see figure 7).

Figure 7 - Percentage of Faculty/Research Staff Using Scientific Work Stations at Doctoral Departments, by Access to Supercomputers

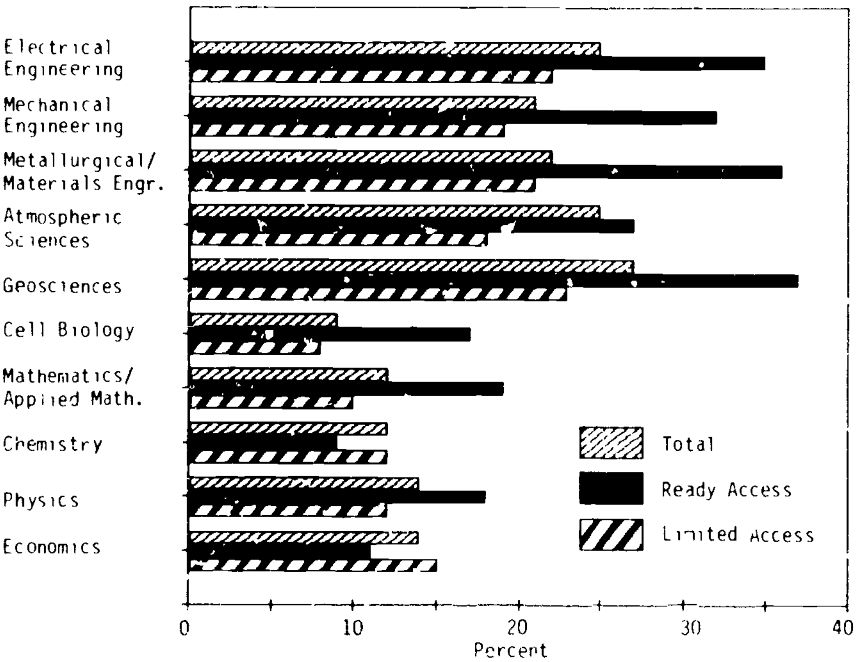
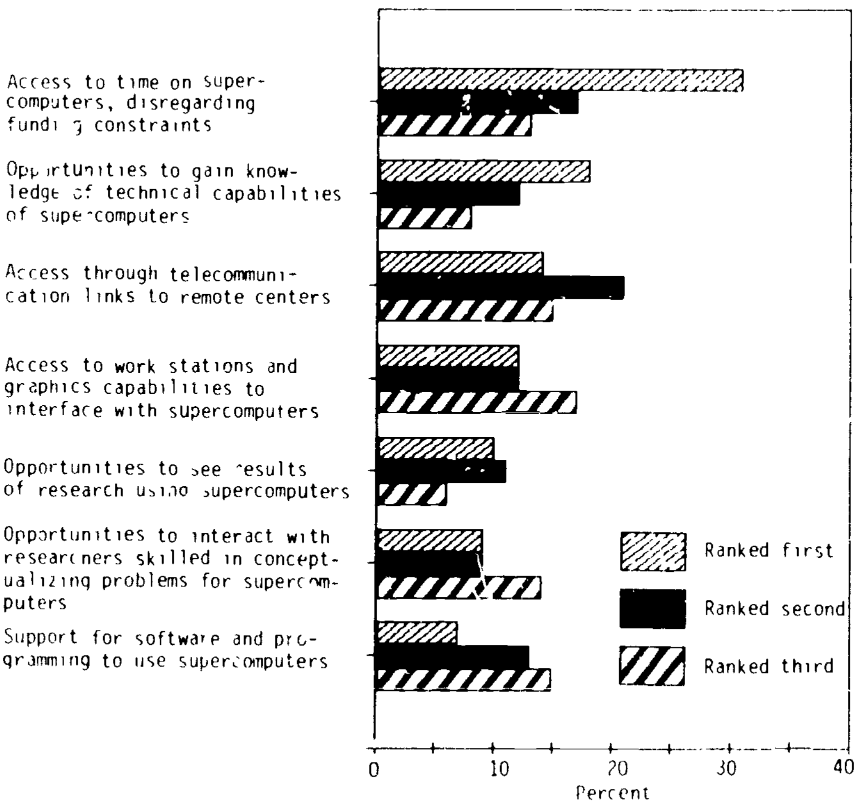


Figure 8 - Types of Assistance Needed to Increase Use of Supercomputers



Applicability of Supercomputers to Research

Respondents were asked to indicate how many of the faculty and professional research personnel in their departments were pursuing lines of research that could benefit from access to supercomputers. The proportion of faculty and research personnel "whose work is now constrained by the capacity or speed of conventional main frame computers" ranged from a high of 20 percent (atmospheric sciences) to a low of 5 percent (cell biology) (see detailed table 4). Finally, the proportion of faculty "whose work is now constrained by the sequential processing design of main frame computers, as opposed to the parallel processing capabilities of advanced large-scale computers" ranged from a high of 13 percent (electrical engineering and mechanical engineering) to a low of 3 percent (economics).

Need for Assistance

Types of assistance needed to increase supercomputer use varied by field. The most frequently ranked first type of assistance was having "access to time on supercomputers, disregarding funding constraints" which 3 in 10 departmental respondents said would have the greatest immediate impact on increasing the use of supercomputers by their faculty and professional research staff (see figure 8). Another 2 in 10 agreed that "opportunities to gain knowledge of technical capabilities of supercomputers" would be most helpful in increasing supercomputer use. The least likely type of assistance to be ranked first was help with software and programming which only 7 percent said would increase supercomputer use in their departments.

Rankings of types of assistance needed were relatively consistent across programs in public and private institutions as well as those in the top 50 and other institutions (see detailed table 8). However, there were some departmental differences. Having access to supercomputers without funding constraints was ranked first by nearly half the departments of physics but by only 6 percent of departments of cell biology (see detailed table 9). In cell biology where supercomputer use is very infrequent, assistance was most often needed in terms of introduction and orientation to supercomputers.

Electrical Engineering: Only 6 percent of the faculty and professional research staff in departments of electrical engineering were currently using, or have used, supercomputers. Another 8 percent had made plans to use supercomputers. Fully 6 in 10 faculty were using conventional main frame computers. Research activities of about 14 percent of faculty were said to be constrained by use of conventional computers. About one-fourth of faculty were regularly using scientific work stations to support their professional research. Finally, one-fourth of the departments of electrical engineering stated that assistance in gaining access to time on supercomputers, disregarding funding constraints as well as having access to scientific work stations and graphics capabilities to interface with supercomputers would greatly increase the use of supercomputers by their faculty and professional research staff.

Mechanical Engineering: About 7 percent of faculty and research staff in departments of mechanical engineering were currently using, or have used, supercomputers and another 11 percent had plans to use them. Over half (55 percent) were currently using conventional main-frame computers. Research activities of 19 percent of the faculty were said to be constrained by the use of conventional computers. Just over 2 in 10 faculty were regularly using scientific work stations. Over 4 in 10 departments agreed that having access to time on supercomputers, disregarding financial constraints would have the greatest immediate impact on increasing supercomputer use of their faculty. Another 2 in 10 agreed that having opportunities to gain knowledge of technical capabilities of supercomputers would also help.

Metallurgical and Materials Engineering: Only 3 percent of the faculty and research staff in such departments were currently using, or have used, supercomputers; another 8 percent had made plans to use them. Just over 4 in 10 faculty were using conventional main-frame computers. Research activities of about 10 percent of faculty were said to be constrained by the use of conventional computers. About 2 in 10 faculty were regularly using scientific work stations. Over 3 in 10 departments agreed that assistance in gaining access to time on supercomputers, disregarding funding constraints, would greatly increase faculty members' use of supercomputers, while about 2 in 10 agreed that having opportunities to gain knowledge of the technical capabilities of supercomputers would be most helpful.

Atmospheric Sciences: The most frequent use of supercomputers was in atmospheric sciences where 23 percent of the faculty and professional research staff were currently using, or had used, supercomputers. and another 12 percent had made plans to use them. In addition, over 4 in 10 faculty were using conventional main frame computers. The research activities of about 2 in 10 faculty were said to be constrained by the use of conventional computers. Just over 2 in 10 were regularly using scientific work stations in their current lines of research. Types of assistance ranked first in terms of having the greatest impact on increasing the use of supercomputers included access to time on supercomputers, regardless of funding constraints (35 percent), access to telecommunications links to remote centers with supercomputers (19 percent), access to work stations and graphics capabilities to interface with supercomputers (19 percent), and support for software and programming (17 percent).

Geosciences: About 5 percent of the faculty and research staff were currently using, or had used, supercomputers; another 7 percent had plans to use them. In addition, 45 percent were currently using conventional main-frame computers. The research activities of about 11 percent of the faculty were said to be constrained by the use of conventional computers. Over one-fourth of the faculty were regularly using scientific work stations in their current lines of research. Types of assistance needed to increase faculty use of supercomputers included having access to time on supercomputers, regardless of funding constraints (23 percent), access through telecommunications links to remote centers with supercomputers (19 percent), and access to scientific work stations with graphics capabilities to interface with supercomputers (19 percent).

Cell Biology: Only 2 percent of faculty and professional research staff in departments of cell biology were currently using, or had used, supercomputers, and another 3 percent had plans to use them. Over 3 in 10 faculty were currently using conventional main-frame computers. The research activities of only about 5 percent of faculty were said to be constrained by the use of conventional computers. Fewer than 1 in 10 faculty had access to scientific work stations. In cell biology where supercomputer use was very infrequent, having access to time on supercomputers without funding constraints was ranked first by only 6 percent of departments. Instead, 28 percent of the departments stated that having opportunities to gain knowledge of the technical capabilities of supercomputers would be most influential in increasing their use, 20 percent agreed that opportunities to see the results of uses of supercomputers to solve a variety of problems (for example, attending special workshops and seminars) would greatly increase use, and 17 percent stated that having opportunities to interact with researchers skilled at conceptualizing problems for supercomputers would help.

Mathematics/Applied Mathematics: Only 4 percent of faculty were currently using, or had used, supercomputers and another 5 percent had plans to use them. Nearly 3 in 10 were using conventional main-frame computers Research activities of fewer than 1 in 10 faculty were said to be constrained by the use of conventional computers. Just over 1 in 10 were regularly using scientific work stations. In terms of assistance needed, over 3 in 10 departments ranked first access to time on supercomputers, regardless of funding constraints, and nearly 2 in 10 ranked first access to scientific work stations with graphics capabilities to interface with supercomputers as the most effective way of increasing supercomputer use in their departments.

Chemistry. Only 3 percent of the faculty and professional research staff at the departments of chemistry were currently using, or had used, supercomputers; another 5 percent had plans to use them. Just over 4 in 10 faculty were currently using conventional main frame computers. Research activities of about 1 in 10 were said to be constrained by the use of conventional computers. Over 1 in 10 were regularly using scientific work stations. About 4 in 10 departments agreed that having access to time on supercomputers, disregarding funding constraints, would increase the use of supercomputers among their faculty, while just under 2 in 10 agreed that having access to telecommunications telecommunications links to remote centers with supercomputers would be most helpful.

Physics. About 7 percent of the faculty and research staff were currently using, or had used, supercomputers, and another 9 percent had plans to use them. In addition, fully half the faculty were using conventional main frame computers. Research activities of nearly 2 in 10 faculty were said to be constrained by the use of conventional computers. About 14 percent were regularly using scientific work stations. Among types of assistance ranked first in terms of having the greatest and immediate impact on faculty use of supercomputers were access to supercomputers without funding constraints (48 percent) and access to telecommunications linkages to remote centers with supercomputers (21 percent).

Economics. Very few faculty at departments of economics were currently using, or had used, supercomputers (2 percent) or had plans to use them (2 percent). Over half (55 percent) were using conventional main frame computers. Research activities of about 7 percent of the faculty were said to be constrained by the use of conventional computers. About 14 percent were regularly using scientific research stations in their current lines of research. Among first ranked types of assistance needed in having the greatest and immediate impact on use of supercomputers were having access to knowledge of the technical capabilities of supercomputers (34 percent) and access to time on supercomputers without any funding constraints (19 percent).

SUMMARY

Over 80 percent of the 1,190 surveyed departments in 10 selected disciplines reported limited access to supercomputers. Only in atmospheric sciences did a majority of departments have ready access to supercomputers. In that field, 20 percent of the faculty and professional research staff are currently using, or have used, supercomputers and another 12 percent are planning to use them in their research. In the remaining fields, supercomputer use is limited to a few faculty and researchers.

In general, departments at institutions ranked in the top 50 according to research and development expenditures had more ready access to supercomputers (almost 25 percent) than did departments in other institutions (15 percent).

Respondents indicated that research pursued by one-eighth of the faculty and research staff at their departments was constrained by the speed and/or sequential processing of conventional main frame machines. Disciplines showing the highest proportion of such limitations were atmospheric sciences, mechanical engineering, physics and electrical engineering.

In general, access time to supercomputers was the first-ranked type of assistance needed to increase their use. The other types of assistance often ranked first were opportunities to gain knowledge about the technical capabilities of supercomputers and access through telecommunications links to remote centers with supercomputers.

DETAILED STATISTICAL TABLES

Table 1--Doctoral Departments with Ready or Limited Access to Supercomputers, 1985

Department	Number of Institutions with- Total	Ready Access	Limited Access	Percentage of Institutions with- Total	Ready Access	Limited Access
			All Institutions			
Electrical Engineering	125	19	106	100.0	15.1	84.9
Mechanical Engineering	122	17	104	100.0	14.2	85.8
Metallurgical/Materials Engineering	73	7	67	100.0	9.3	90.7
Atmospheric Sciences	47	28	19	100.0	60.3	39.7
Geosciences	107	17	90	100.0	15.9	84.1
Cell Biology	138	15	123	100.0	10.9	89.1
Mathematics/Applied Mathematics	144	27	117	100.0	18.4	81.6
Chemistry	166	25	141	100.0	14.9	85.1
Physics	145	34	111	100.0	23.3	76.7
Economics	124	11	113	100.0	8.9	91.1
			Public Institutions			
Electrical Engineering	85	13	72	100.0	15.0	85.0
Mechanical Engineering	82	11	72	100.0	13.3	86.7
Metallurgical/Materials Engineering	49	4	45	100.0	8.1	91.9
Atmospheric Sciences	37	26	11	100.0	71.2	28.8
Geosciences	72	12	60	100.0	17.1	82.9
Cell Biology	89	13	76	100.0	14.1	85.9
Mathematics/Applied Mathematics	97	16	81	100.0	16.9	83.1
Chemistry	112	16	96	100.0	14.6	85.4
Physics	94	23	71	100.0	24.7	75.3
Economics	82	10	72	100.0	11.7	88.3
			Private Institutions			
Electrical Engineering	40	6	34	100.0	15.2	84.8
Mechanical Engineering	39	6	33	100.0	16.1	83.9
Metallurgical/Materials Engineering	24	3	21	100.0	11.7	88.3
Atmospheric Sciences	10	2	8	100.0	20.0	80.0
Geosciences	35	5	30	100.0	13.5	86.5
Cell Biology	49	3	46	100.0	5.2	94.8
Mathematics/Applied Mathematics	47	10	37	100.0	21.6	78.4
Chemistry	54	8	46	100.0	15.6	84.4
Physics	51	11	40	100.0	20.8	79.2
Economics	42	1	41	100.0	3.4	96.6
			Top 50 Institutions			
Electrical Engineering	42	11	32	100.0	25.0	75.0
Mechanical Engineering	40	7	33	100.0	17.9	82.1
Metallurgical/Materials Engineering	32	5	27	100.0	15.8	84.2
Atmospheric Sciences	25	16	9	100.0	64.7	35.3
Geosciences	44	9	36	100.0	19.4	80.6
Cell Biology	45	1[illegible]	35	100.0	23.3	76.7
Mathematics/Applied Mathematics	46	13	33	100.0	27.3	72.7
Chemistry	46	10	36	100.0	21.2	78.8
Physics	46	9	37	100.0	19.4	80.6
Economics	45	3	42	100.0	6.5	93.5

Table 2--Doctoral Departments with Limited Access Rating Importance of Gaining Access to Supercomputers, 1985

Department	Number of Institutions: Total	Number of Institutions: Low Priority	Number of Institutions: Middle Priority	Number of Institutions: High Priority	Percentage of Institutions: Total	Percentage of Institutions: Low Priority	Percentage of Institutions: Middle Priority	Percentage of Institutions: High Priority
All Institutions								
Electrical Engineering	106	31	58	16	100.0	29.6	55.0	15.3
Mechanical Engineering	104	24	43	37	100.0	22.7	41.4	36.0
Metallurgical/Materials Engineering	67	21	35	11	100.0	31.6	52.5	15.9
Atmospheric Sciences	19	2	8	9	100.0	8.2	43.3	48.5
Geosciences	90	33	34	23	100.0	37.1	37.5	25.4
Cell Biology	123	77	38	8	100.0	62.3	31.3	6.4
Mathematics/Applied Mathematics	117	41	47	30	100.0	34.7	40.0	25.2
Chemistry	141	46	60	34	100.0	32.9	42.7	24.4
Physics	111	15	55	41	100.0	13.5	49.8	36.7
Economics	113	78	30	5	100.0	69.0	26.3	4.7
Public Institutions								
Electrical Engineering	72	22	40	10	100.0	31.0	54.9	14.1
Mechanical Engineering	72	20	26	26	100.0	[illegible]	35.7	36.6
Metallurgical/Materials Engineering	45	14	[illegible]	7	100.0	30.3	54.4	15.3
Atmospheric Sciences	11	2	6	[illegible]	100.0	14.3	57.1	28.6
Geosciences	60	22	22	15	100.0	37.6	37.3	25.1
Cell Biology	76	52	22	3	100.0	67.4	29.0	3.6
Mathematics/Applied Mathematics	81	27	37	17	100.0	33.7	45.7	20.6
Chemistry	96	28	40	27	100.0	29.6	42.1	28.3
Physics	71	11	33	26	100.0	15.9	47.0	37.1
Economics	72	52	18	2	100.0	71.7	25.0	3.3
Private Institutions								
Electrical Engineering	34	9	19	6	100.0	26.8	55.3	17.9
Mechanical Engineering	33	4	18	11	100.0	11.6	53.8	34.6
Metallurgical/Materials Engineering	[illegible]	7	10	4	100.0	34.3	48.5	17.2
Atmospheric Sciences	8	0	2	6	100.0	0.0	25.0	75.0
Geosciences	30	11	11	8	100.0	36.3	37.8	25.9
Cell Biology	46	25	16	5	100.0	54.0	35.0	11.0
Mathematics/Applied Mathematics	37	14	10	13	100.0	36.9	27.8	35.4
Chemistry	46	18	20	7	100.0	39.7	44.0	16.3
Physics	40	4	22	15	100.0	9.2	54.8	36.0
Economics	41	26	12	3	100.0	64.3	28.6	7.1
Top 50 Institutions								
Electrical Engineering	32	9	15	8	100.0	28.6	47.6	23.8
Mechanical Engineering	33	7	10	16	100.0	21.7	30.4	47.8
Metallurgical/Materials Engineering	27	8	12	7	100.0	31.3	43.8	25.0
Atmospheric Sciences	9	0	1	7	100.0	0.0	16.7	83.3
Geosciences	[illegible]	11	13	11	100.0	32.0	36.0	32.0
Cell Biology	[illegible]	15	14	6	100.0	43.5	39.1	17.4
Mathematics/Applied Mathematics	33	10	11	13	100.0	29.2	33.3	37.5
Chemistry	36	4	15	17	100.0	11.5	42.3	46.2
Physics	37	4	16	16	100.0	12.0	44.0	44.0
Economics	42	28	12	[illegible]	100.0	65.5	27.6	6.9

Table 3--Present Level of Computer Use by Doctoral Department Faculty/Research Staff, 1985

Departments	Total Faculty No.	Total Faculty %	Using Supercomputers No.	Using Supercomputers %	Planning to Use Supercomputers No.	Planning to Use Supercomputers %	Using Conventional Computers No	Using Conventional Computers %	Currently Not Using Conventional Computers No.	Currently Not Using Conventional Computers %	Computer Use Unknown No.	Computer Use Unknown %
All Institutions												
Electrical Engineering	3,473	100.0	199	5.7	269	7.7	2,075	59.7	581	16.7	349	10.1
Mechanical Engineering	2,654	100.0	175	6.6	288	10.8	1,455	54.8	573	21.6	163	6.1
Metallurgical/Materials Engineering	1,029	100.0	29	2.8	82	8.0	433	42.1	328	31.9	158	15.3
Atmospheric Sciences	839	100.0	190	22.6	104	12.4	364	43.4	157	18.7	24	2.9
Geosciences	2,110	100.0	113	5.4	156	7.4	943	44.7	731	34.6	167	7.9
Cell Biology	4,584	100.0	88	1.9	119	2.6	1,565	34.1	2,478	54.1	335	7.3
Mathematics/Applied Math	5,236	100.0	213	4.1	280	5.3	1,527	29.2	2,757	52.6	460	8.8
Chemistry	5,534	100.0	155	2.8	292	5.3	2,254	40.7	2,464	44.5	369	6.7
Physics	4,960	100.0	368	7.4	441	8.9	2,491	50.2	1,226	24.7	435	8.8
Economics	3,069	100.0	48	1.6	50	1.6	1,680	54.7	1,118	36.4	172	5.6
Public Institutions												
Electrical Engineering	2,313	100.0	148	6.4	189	8.2	1,331	57.5	423	18.3	223	9.6
Mechanical Engineering	1,891	100.0	126	6.7	218	11.5	961	50.8	447	23.6	138	7.3
Metallurgical/Materials Engineering	681	100.0	21	3.1	57	8.3	315	46.1	234	34.3	56	8.2
Atmospheric Sciences	713	100.0	178	25.0	92	12.9	290	40.7	135	18.9	18	2.5
Geosciences	1,528	100.0	97	6.3	115	7.5	688	45.0	519	33.9	110	7.2
Cell Biology	3,189	100.0	54	1.7	50	1.6	1,117	35.0	1,773	55.6	195	6.1
Mathematics/Applied Math	3,969	100.0	153	3.9	207	5.2	1,153	29.1	2,141	53.9	314	7.9
Chemistry	3,803	100.0	108	2.8	196	5.2	1,491	39.2	1,804	47.4	205	5.4
Physics	3,449	100.0	277	8.0	291	8.4	1,724	50.0	827	24.0	331	9.6
Economics	2,096	100.0	34	1.6	37	1.8	1,203	57.4	702	33.5	120	5.7

Table 3--Continued

Departments	Total Faculty No.	Total Faculty %	Using Supercomputers No.	Using Supercomputers %	Planning to Use Supercomputers No.	Planning to Use Supercomputers %	Using Conventional Computers No	Using Conventional Computers %	Currently Not Using Conventional Computers No.	Currently Not Using Conventional Computers %	Computer Use Unknown No.	Computer Use Unknown %
Private Institutions												
Electrical Engineering	1,159	100.0	51	4.4	80	6.9	744	64.2	158	13.6	126	10.9
Mechanical Engineering	763	100.0	49	6.4	69	9.1	493	64.7	126	16.5	25	3.3
Metallurgical/Materials Engineering	348	100.0	8	2.3	25	7.2	118	34.0	94	27.1	102	29.4
Atmospheric Sciences	126	100.0	12	9.5	12	9.5	74	58.7	22	17.5	6	4.8
Geosciences	582	100.0	16	2.7	41	7.0	255	43.8	213	36.6	57	10.0
Cell Biology	1,396	100.0	35	2.5	69	4.9	448	32.1	705	50.5	140	10.0
Mathematics/Applied Math	1,268	100.0	60	4.7	72	5.7	374	29.5	616	48.6	145	11.4
Chemistry	1,730	100.0	47	2.7	97	5.6	763	44.1	660	38.2	164	9.5
Physics	1,511	100.0	91	6.0	150	9.9	767	50.8	399	26.4	103	6.8
Economics	973	100.0	14	1.4	13	1.3	477	49.0	416	42.8	52	5.3
Top 50 Institutions												
Electrical Engineering	1,781	100.0	83	4.7	113	6.3	1,041	58.4	302	17.0	243	13.6
Mechanical Engineering	998	100.0	80	8.0	126	12.6	562	56.3	190	19.0	40	4.0
Metallurgical/Materials Engineering	481	100.0	25	5.2	52	10.8	160	33.3	137	28.5	107	22.2
Atmospheric Sciences	395	100.0	113	28.6	43	10.9	151	38.2	75	19.0	13	3.3
Geosciences	1,054	100.0	61	5.8	82	7.8	453	43.0	347	33.0	110	10.4
Cell Biology	1,818	100.0	57	3.1	68	3.7	618	34.0	909	50.0	167	9.2
Mathematics/Applied Math	2,332	100.0	111	4.8	108	4.6	671	28.8	1,194	51.2	247	10.0
Chemistry	2,606	100.0	92	3.5	149	5.7	1,357	52.1	888	34.1	121	4.6
Physics	2,239	100.0	161	7.2	182	8.1	1,175	52.5	531	23.7	189	8.4
Economics	1,456	100.0	7	0.5	19	1.3	826	56.7	507	34.8	96	6.6

Table 4--Applicability of Supercomputers to Present Lines of Research at Doctoral Departments, 1985

Department	Number of Faculty/Research Staff: Total Faculty	Number of Faculty/Research Staff: Currently Using Super-computers*	Number of Faculty/Research Staff: Currently Constrained by Limited Speed	Number of Faculty/Research Staff: Currently Constrained by Sequential Processing	Percentage of Faculty/Research Staff: Total Faculty	Percentage of Faculty/Research Staff: Currently Using Super-computers*	Percentage of Faculty/Research Staff: Currently Constrained by Limited Speed	Percentage of Faculty/Research Staff: Currently Constrained by Sequential Processing
All Institutions								
Electrical Engineering	3,473	281	497	433	100.0	8.1	14.3	12.5
Mechanical Engineering	2,654	225	500	336	100.0	8.5	16.9	12.7
Metallurgical/Materials Engineering	1,029	43	105	54	100.0	4.2	10.2	5.2
Atmospheric Sciences	839	236	163	95	100.0	28.1	19.5	11.3
Geosciences	2,110	166	228	122	100.0	7.9	10.8	5.8
Cell Biology	4,584	126	236	194	100.0	2.7	5.1	4.2
Mathematics/Applied Mathematics	5,236	303	457	341	100.0	5.8	8.7	6.5
Chemistry	5,534	172	571	304	100.0	3.1	10.3	5.5
Physics	4,960	508	845	435	100.0	10.2	17.0	8.8
Economics	3,069	85	214	94	100.0	2.8	7.0	3.1
Public Institutions								
Electrical Engineering	2,313	147	348	286	100.0	6.3	15.0	12.3
Mechanical Engineering	1,891	159	349	241	100.0	8.4	18.5	12.8
Metallurgical/Materials Engineering	681	29	70	39	100.0	4.3	10.3	5.7
Atmospheric Sciences	713	218	155	95	100.0	30.5	21.8	13.3
Geosciences	1,528	129	156	87	100.0	8.5	10.2	5.7
Cell Biology	3,189	95	145	120	100.0	3.0	4.5	3.8
Mathematics/Applied Mathematics	3,969	231	358	275	100.0	5.8	9.0	6.9
Chemistry	3,803	127	392	260	100.0	3.3	10.3	6.8
Physics	3,449	360	593	299	100.0	10.4	17.2	8.7
Economics	2,096	58	140	58	100.0	2.8	6.7	2.8
Private Institutions								
Electrical Engineering	1,159	135	149	147	100.0	11.6	12.8	12.7
Mechanical Engineering	763	67	151	94	100.0	8.7	19.8	12.4
Metallurgical/Materials Engineering	348	14	35	15	100.0	4.0	10.0	4.3
Atmospheric Sciences	126	18	8	0	100.0	14.3	6.3	0.0
Geosciences	582	37	72	35	100.0	6.4	12.4	6.1
Cell Biology	1,396	31	91	74	100.0	2.2	6.5	5.3
Mathematics/Applied Mathematics	1,268	72	99	66	100.0	5.7	7.8	5.2
Chemistry	1,730	46	179	44	100.0	2.6	10.4	2.6
Physics	1,511	148	253	137	100.0	9.8	16.7	9.0
Economics	973	28	74	36	100.0	2.8	7.6	3.7
Top 50 Institutions								
Electrical Engineering	1,781	84	252	227	100.0	4.7	14.2	12.7
Mechanical Engineering	998	96	197	106	100.0	9.6	19.8	10.6
Metallurgical/Materials Engineering	481	23	37	22	100.0	4.9	7.6	4.5
Atmospheric Sciences	395	118	49	28	100.0	29.7	12.3	7.1
Geosciences	1,054	100	116	60	100.0	9.5	11.0	5.7
Cell Biology	1,818	53	177	149	100.0	2.9	9.7	8.2
Mathematics/Applied Mathematics	2,332	160	206	147	100.0	6.9	8.8	6.3
Chemistry	2,606	96	309	142	100.0	3.7	11.8	5.4
Physics	2,239	228	408	160	100.0	10.2	18.2	7.1
Economics	1,456	17	68	29	100.0	1.2	4.7	2.0

* Also includes those already in touch with appropriate research facilities.

Table 5--Applicability of Supercomputers to Present Lines of Research, by Degree of Access to Supercomputers, 1985

Department	Number of Faculty/Research Staff: Total Faculty	Number: Currently Using Super-computers*	Number: Currently Constrained by Limited Speed	Number: Currently Constrained by Sequential Processing	Percentage of Faculty/Research Staff: Total Faculty	Percentage: Currently Using Super-computers*	Percentage: Currently Constrained by Limited Speed	Percentage: Currently Constrained by Sequential Processing
Institutions Where Faculty Have Ready Access to Supercomputers								
Electrical Engineering	862	88	156	150	100.0	9.9	17.7	17.0
Mechanical Engineering	333	48	64	50	100.0	14.4	19.3	15.1
Metallurgical/Materials Engineering	53	4	4	1	100.0	7.7	7.9	1.9
Atmospheric Sciences	583	214	131	81	100.0	36.7	22.5	14.0
Geosciences	483	55	53	35	100.0	11.3	11.1	7.2
Cell Biology	600	23	84	79	100.0	3.9	14.0	13.1
Mathematics/Applied Mathematics	1,060	159	79	65	100.0	15.0	7.4	6.1
Chemistry	950	52	88	48	100.0	5.5	9.2	5.1
Physics	1,460	224	230	133	100.0	15.4	15.7	9.1
Economics	347	46	19	14	100.0	13.3	5.6	4.1
Institutions Where Faculty Have Limited Access to Supercomputers								
Electrical Engineering	2,591	194	341	283	100.0	7.5	13.1	10.9
Mechanical Engineering	2,321	178	436	286	100.0	7.7	18.8	12.3
Metallurgical/Materials Engineering	977	39	101	53	100.0	4.0	10.4	5.4
Atmospheric Sciences	256	22	32	14	100.0	8.4	12.6	5.3
Geosciences	1,627	112	175	88	100.0	6.9	10.8	5.4
Cell Biology	3,984	103	152	115	100.0	2.6	3.8	2.9
Mathematics/Applied Mathematics	4,176	144	379	276	100.0	3.5	9.1	6.6
Chemistry	4,584	120	483	256	100.0	2.6	10.5	5.6
Physics	3,500	284	616	302	100.0	8.1	17.6	8.6
Economics	2,721	39	195	80	100.0	1.4	7.2	2.9

* Also includes those already in touch with appropriate research facilities.

22

Table 6--Present Use of Scientific Work Stations by Doctoral Department Faculty/Research Staff, 1985

Department	Total Faculty	Faculty Using Work Stations: Number	Faculty Using Work Stations: Percent	Total Faculty	Faculty Using Work Stations: Number	Faculty Using Work Stations: Percent
	All Institutions			**Top 50 Institutions**		
Electrical Engineering	3,473	883	25.4	1,781	398	22.3
Mechanical Engineering	2,654	550	20.7	998	217	21.8
Metallurgical/Materials Engineering	1,029	225	21.8	481	85	17.7
Atmospheric Sciences	839	206	24.6	395	101	25.7
Geosciences	2,110	559	26.5	1,054	190	18.0
Cell Biology	4,584	415	9.0	1,818	170	9.3
Mathematics/Applied Mathematics	5,236	613	11.7	2,332	303	13.0
Chemistry	5,534	642	11.6	2,606	215	8.3
Physics	4,960	677	13.6	2,239	218	9.7
Economics	3,069	438	14.3	1,456	238	16.3
	Public Institutions			**Private Institutions**		
Electrical Engineering	2,313	573	24.8	1,159	310	26.7
Mechanical Engineering	1,891	373	19.7	763	177	23.3
Metallurgical/Materials Engineering	681	168	24.6	348	57	16.4
Atmospheric Sciences	713	202	28.3	126	4	3.2
Geosciences	1,528	410	26.8	582	149	25.6
Cell Biology	3,189	269	8.4	1,396	146	10.4
Mathematics/Applied Mathematics	3,969	394	9.9	1,268	219	17.3
Chemistry	3,803	345	9.1	1,730	297	17.1
Physics	3,449	461	13.4	1,511	216	14.3
Economics	2,096	315	15.0	973	123	12.7

Table 7--Present Use of Scientific Work Stations by Doctoral Department Faculty/Research Staff, by Degree of Access to Supercomputers, 1985

Department	Ready Access			Limited Access		
	Total Faculty	Faculty Using Work Stations Number	Faculty Using Work Stations Percent	Total Faculty	Faculty Using Work Stations Number	Faculty Using Work Stations Percent
			All Institutions			
Electrical Engineering	882	306	34.7	2,591	577	22.3
Mechanical Engineering	333	107	32.0	2,321	444	19.1
Metallurgical/Materials Engineering	53	19	35.8	977	206	21.1
Atmospheric Sciences	583	160	27.4	256	47	18.2
Geosciences	483	178	36.9	1,627	381	23.4
Cell Biology	600	103	17.2	3,984	311	7.8
Mathematics/Applied Mathematics	1,060	198	18.7	4,176	415	9.9
Chemistry	950	88	9.2	4,584	554	12.1
Physics	1,460	267	18.3	3,500	410	11.7
Economics	347	38	11.1	2,721	400	14.7
			Public Institutions			
Electrical Engineering	456	177	38.8	1,857	396	21.3
Mechanical Engineering	241	84	34.8	1,650	289	17.5
Metallurgical/Materials Engineering	37	15	40.7	645	153	23.7
Atmospheric Sciences	543	160	29.4	170	43	25.0
Geosciences	425	135	31.7	1,103	275	24.9
Cell Biology	550	103	18.8	2,638	165	6.3
Mathematics/Applied Mathematics	756	101	13.4	3,213	293	9.1
Chemistry	580	32	5.5	3,223	313	9.7
Physics	1,126	228	20.3	2,323	233	10.0
Economics	310	38	12.4	1,786	276	15.5
			Private Institutions			
Electrical Engineering	426	129	30.4	734	181	24.6
Mechanical Engineering	92	23	24.7	671	155	23.1
Metallurgical/Materials Engineering	16	4	24.8	332	53	16.0
Atmospheric Sciences	40	0	0.0	86	4	4.7
Geosciences	57	43	75.7	524	106	20.1
Cell Biology	50	0	0.0	1,346	146	10.8
Mathematics/Applied Mathematics	304	97	31.9	963	122	12.6
Chemistry	370	56	15.1	1,360	241	17.7
Physics	334	38	11.5	1,177	177	15.1
Economics	38	0	0.0	935	123	13.2
			Top 50 Institutions			
Electrical Engineering	698	216	31.0	1,083	182	16.8
Mechanical Engineering	147	54	36.9	851	163	19.2
Metallurgical/Materials Engineering	45	18	40.7	436	67	15.3
Atmospheric Sciences	307	94	30.6	88	7	8.3
Geosciences	279	37	13.3	775	153	19.7
Cell Biology	459	42	9.2	1,359	128	9.4
Mathematics/Applied Mathematics	553	121	21.9	1,779	182	10.2
Chemistry	552	24	4.3	2,054	192	9.3
Physics	490	28	5.7	1,749	189	10.8
Economics	170	6	3.4	1,286	232	18.0

Table 8--Number of Departments Ranking Assistance Needed to Increase Use of Supercomputers, 1985

Types of Assistance	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
			All Institutions		
Opportunities to gain knowledge of technical capabilities of supercomputers	214	140	98	89	117
Opportunities to interact with researchers skilled in conceptualizing problems	103	112	169	129	195
Access through telecommunications links to remote centers	163	252	174	123	101
Access to time on supercomputers, disregarding funding constraints	363	207	153	118	67
Support for software and programming to use supercomputers	82	156	183	219	142
Access to work stations and graphics capabilities to interface with supercomputers	136	146	202	179	101
Opportunities to see results of research using supercomputers	123	125	73	79	99
			Public Institutions		
Opportunities to gain knowledge of technical capabilities of supercomputers	151	99	63	53	84
Opportunities to interact with researchers skilled in conceptualizing problems	67	70	111	91	143
Access through telecommunications links to remote centers	112	170	127	81	63
Access to time on supercomputers, disregarding funding constraints	233	127	107	87	45
Support for software and programming to use supercomputers	51	111	119	153	90
Access to work stations and graphics capabilities to interface with supercomputers	84	99	135	123	65
Opportunities to see results of research using supercomputers	78	73	47	50	71
			Private Institutions		
Opportunities to gain knowledge of technical capabilities of supercomputers	63	41	34	36	33
Opportunities to interact with researchers skilled in conceptualizing problems	36	42	58	38	52
Access through telecommunications links to remote centers	51	82	47	42	38
Access to time on supercomputers, disregarding funding constraints	130	80	47	31	22
Support for software and programming to use supercomputers	31	45	64	66	52
Access to work stations and graphics capabilities to interface with supercomputers	52	48	67	56	36
Opportunities to see results of research using supercomputers	45	51	27	29	29
			Top 50 Institutions		
Opportunities to gain knowledge of technical capabilities of supercomputers	64	43	36	30	52
Opportunities to interact with researchers skilled in conceptualizing problems	28	37	42	70	70
Access through telecommunications links to remote centers	55	100	68	34	31
Access to time on supercomputers, disregarding funding constraints	152	86	48	40	24
Support for software and programming to use supercomputers	33	56	81	88	42
Access to work stations and graphics capabilities to interface with supercomputers	52	56	74	56	39
Opportunities to see results of research using supercomputers	32	33	25	28	43

Table 9 - Percentage of Departments Ranking First Types of Assistance Needed to Increase Use of Supercom s, 1985

Type of Assistance	Engineering Electrical	Engineering Mechanical	Engineering Metallurgical	Atmospheric Sciences	Geo Sciences	Cell Biology	Mathematics	Chemistry	Physics	Economics
Opportunities to gain knowledge of technical capabilities of supercomputers	13.6	19.2	20.8	8.3	19.0	27.5	10.4	13.3	12.4	33.9
Opportunities to interact with researchers skilled in conceptualizing problems	8.8	3.3	5.6	6.3	11.4	16.7	9 0	8.5	5.5	9.7
Access through telecommunications links to remote centers	12.8	19.2	12.5	18.8	19.0	5.1	12.5	17.0	21.4	2.4
Access to time on supercomputers, disregarding funding constraints	24.0	44.2	33.3	35.4	22.9	5.8	32.7	40.0	48.3	19.4
Support for software and programming to use supercomputers	8.0	3.3	1.4	16.7	3.8	5.8	9.0	6.1	5.5	13.7
Access to work stations and graphics capabilities to interface with supercomputers	24.8	7.5	6.9	18.8	9.5	8.7	18.8	9.1	8.3	5.6
Opportunities to see results of research using supercomputers	9.6	10.0	15.3	4.2	9.5	19.6	7.6	7.3	4.8	15.3

APPENDIX A: SURVEY INSTRUMENT

AMERICAN COUNCIL ON EDUCATION

Higher Education Panel

HEP Survey No. 69

ACCESS TO COMPUTERS FOR RESEARCH

RESPONDENT DESIGNATOR FORM

> For each department/discipline listed, indicate whether your institution conducts doctoral study in the field. If it does, please complete a questionnaire for that department. Most large universities will thus complete 10 questionnaires--one for each department listed.

Is doctoral study/ research conducted in the department/ discipline? YES	NO	DEPARTMENT/DISCIPLINE	NAME AND TELEPHONE of person designated to respond for the department listed. (Only doctoral level departments/ disciplines are to be surveyed.)
		ENGINEERING	
____	____	Electrical Engineering	____
____	____	Mechanical Engineering	____
____	____	Metallurgical and Materials Engineering	____
		ENVIRONMENTAL SCIENCES	
____	____	Atmospheric Sciences	____
____	____	Geosciences	____
		LIFE SCIENCES	
____	____	Cell Biology	____
		MATHEMATICAL/COMPUTER SCIENCES	
____	____	Mathematics & Applied Mathematics	____
		PHYSICAL SCIENCES	
____	____	Chemistry	____
____	____	Physics	____
		SOCIAL SCIENCES	
____	____	Economics	____

> Please indicate whether **follow up contact** should be made through your office or directly with a department person listed above
>
> ☐ Follow-up contact should be with the HEP Representative
>
> ☐ Follow-up contact should be made directly with the department

BEST COPY AVAILABLE

27

OMB # 3145-0009
Exp 03-31-87

AMERICAN COUNCIL ON EDUCATION

Higher Education Panel Survey Number 69

ACCESS TO COMPUTERS FOR RESEARCH

This survey requests information about computer use and plans for computer use by faculty and other professional research staff in this department. Some of the questions are subjective; your judgments are important to us. Please give us your estimates wherever you can.

Please use the following distinctions when responding to the questions.

Advanced large-scale computers, or advanced scientific computers (sometimes referred to in the media as "supercomputers"): machines performing at least 100 million floating point operations per second. At present, only **Cray X-MP** and **Cyber 205** machines meet this criterion.

Conventional main frame computers: computers with capacity less than that of advanced large-scale machines. This group includes those in the IBM-308X series, VAX-7XX series, and the CDC-7600.

Scientific work station: a 32-bit machine with memory of at least one megabyte, screen resolution on the order of 800 × 1,000 in order to adequately display a full range of graphics, and the ability to work in an integrated network environment with UNIX-like operating system and a Fortran compiler. Exclude personal computers used as word processors and word processors with business graphics capabilities.

Department of ____

1. Faculty and Research Staff. What is the total number of full-time faculty and other professional research staff in this Department? *Exclude* (1) faculty who are away from campus on sabbatical and (2) graduate students participating in research projects, whether salaried or on other support

Full-time faculty and research staff (headcount) ____

2. Present Use of Computers and Scientific Work Stations.

a. Computers. How many of the persons reported in question 1 above make use of **advanced large-scale computers** as described here? Please count for each person only once in the list below and treat the list as hierarchical

Level of Computer Use	Number of Persons
1. Currently using or have used advanced large-scale computers	____
2. Currently formulating plans for research requiring advanced large-scale computers, or taking concrete steps to pursue an interest in them	____
3. Now using conventional main frame computers, (e g , IBM, VAX, CDC-7600, etc) as an integral part of their research	____
4. Now making no use of conventional main frame computers	____
5. Unable to determine or do not know	____
Total (should agree with figure in question 1)	____

b. Scientific Work Stations. How many of the persons reported in question 1 above make regular use of scientific work stations (as defined on the opposite page) to support their professional research?

Number of Persons ____

3. Applicability of Advance Large-scale Computers to Present Lines of Research. How many of the persons reported in question 1 are pursuing lines of research that *could benefit* from access to **advanced large-scale computers?** Include persons in as many categories as appropriate

Category	Number of Persons
a. Personnel who are already in touch with appropriate research facilities or are using advanced large-scale computers.	____
b. Personnel whose work is now constrained by the capacity or speed of conventional main frame computers	____
c. Personnel whose work is now constrained by the sequential processing design of main frame computers, as opposed to the parallel processing capabilities of advanced large-scale computers.	____

Continued on next page.

4. Need for Assistance. Which of the following types of assistance would have the *greatest immediate impact* on increasing the use of **advanced large-scale computers** by the faculty and research staff identified in question 1? Please rank, in order of importance as many types of assistance as you believe applicable. Use "1" for the highest ranked item.

Type of Assistance	Rank
a. Opportunities to gain knowledge of the technical capabilities of advanced large-scale computers	______
b. Opportunities to interact with researchers skilled at conceptualizing problems for advanced large-scale computers	______
c. Access through telecommunications links to remote centers with advanced large-scale computers	______
d. Access to time on advanced large-scale computers, disregarding funding constraints	______
e. Support for software and programming to use advanced large-scale computers	______
f. Access to scientific work stations and graphics capabilities to interface with advanced large-scale computers	______
g. Opportunities to see the results of uses of advanced large-scale computers to solve a variety of problems, for example, opportunities to attend special workshops and seminars.	______
h. Other needs, please specify	______

____

____

____

5. Current Access. Do faculty members and other professional research staff in this department have ready access to an **advanced large-scale computer?**

Yes ______
No ______

If no, what level of priority does obtaining ready access to an advanced large-scale computer have? Circle the appropriate number below.

High priority	3
Medium priority	2
Low priority	1

Thank you for your assistance. Please return this form to

Higher Education Panel
American Council on Education
One Dupont Circle Suite 829
Washington, DC 20036

by **May 17, 1985.**

Please keep a copy of this form for your records.

Person completing the form

Name ______________________

Title ______________________

Telephone (   ) ______________________

APPENDIX B: METHODS SUMMARY

The Higher Education Panel forms the basis of an ongoing survey research program created in 1971 by the American Council on Education. Its purpose is to conduct specialized surveys on topics of current policy interest to the higher education community and to governmental agencies.

The Panel is a disproportionate stratified sample of 1,040 colleges and universities, divided into two half-samples of 520 institutions each. Institutions were drawn from the more than 3,200 colleges and universities listed in the National Center for Education Statistics' Education Directory, Colleges and Universities. All institutions in the population are grouped according to the Panel's stratification design, which is based primarily upon institutional type (doctorate-granting, comprehensive, baccalaureate, specialized and two-year academic or occupational), control (public, private), and size (full-time equivalent undergraduate enrollment, full-time equivalent graduate enrollment, and educational and general expenditures).
For any given survey, either the entire Panel, a half-sample, or an appropriate subgroup is used.

The survey operation is dependent upon a network of campus representatives who, through their presidents, have agreed to participate. The representatives receive the Panel questionnaires and direct them to the most appropriate campus officials for response.

The survey population was defined as all major research universities that award five or more doctoral degrees and have at least one of the departments under study: that is, electrical engineering, mechanical engineering, metallurgical/materials engineering, atmospheric sciences, geosciences, cell biology, mathematics/applied mathematics, chemistry, physics, and economics. With the exception of schools of engineering, all specialized schools (that is, schools of divinity, medicine, other health, business, fine arts, law, and education) were excluded.

The survey instrument (see Appendix A) was mailed to 207 institutions in mid-April 1985. Responses from 23 institutions indicated that they did not meet survey criteria, reducing the number of institutions from which substantive responses could be expected to 184. After mail and telephone followups, 167 institutions (91 percent) responded with at least one departmental questionnaire completed.

Non-Response Adjustment Procedure

After examining the National Center for Education Statistics' records and other listings, it was determined that 185 institutions (only one non-Panel member) and about 1,190 departments met the study eligibility criteria nation-wide. For purposes of non-response adjustment, and to compensate for the non-Panel institution which was treated as a non-respondent, departmental weights were developed for each institution in each stratification cell, based on the ratio of responding departments to nonresponding departments. Due to small number of institutions involved, engineering schools from Panel stratification cells 5 (public specialized schools) and 6 (private specialized schools) were combined with cells 3 (public comprehensive universities) and 4 (private comprehensive universities). Further, separate weights were developed and applied to data showing differences by top 50 status of institutions. The procedure used was again based on the ratio of responding departments to nonresponding departments in each top 50 and other institution in each stratification cell.

Tables B-1 and B-2 show the number of population and responding departments in each cell and corresponding weights. Table B-3 presents the weighted national estimates (number of departments and faculty) reported in the study.

Table B-1, Departmental Population and Respon[illegible]
by Stratification Cells and for Top 50 Institutions

Department	Public Doctoral Responding	Public Doctoral Population	Private Doctoral Responding	Private Doctoral Population	*Public Comprehensive Responding	*Public Comprehensive Population	*Private Comprehensive Responding	*Private Comprehensive Population	Top 50 Institutions Responding	Top 50 Institutions Population
Electrical Engineering	57	74	23	35	10	11	5	5	28	42
Mechanical Engineering	49	69	27	34	11	12	4	5	28	40
Metallurgical/Materials Engineering	31	43	11	20	4	5	4	4	18	30
Atmospheric Sciences	23	35	5	10	2	2	0	1	17	25
Geosciences	52	65	[illegible]	31	6	7	1	2	30	43
Cell Biology	58	80	32	41	6	9	7	9	30	45
Mathematics/Applied Math	75	90	29	42	7	7	5	5	33	46
Chemistry	74	95	38	47	16	16	7	7	33	46
Physics	65	84	34	45	9	10	5	6	31	46
Economics	61	77	29	42	4	5	0	0	31	45

Table B-2. Departmental Weights, by Type and Control of Institution

Department	Public Doctoral	Private Doctoral	*Public Comprehensive	*Private Comprehensive	Top 50 Institutions
Electrical Engineering	1.30	1.52	1.10	1.00	1.50
Mechanical Engineering	1.41	1.26	1.09	1.25	1.43
Metallurgical/Materials Engineering	1.39	1.82	1.25	1 00	1.67
Atmospheric Sciences	1.52	2.00	1.00	0.0	1.47
Geosciences	1.25	1.55	1.17	2.00	1.43
Cell Biology	1.38	1.28	1.50	1 14	1.50
Mathematics/Applied Math	1.20	1.45	1.00	1.00	1.39
Chemistry	1.28	1.24	1.00	1.00	1.39
Physics	1.29	1.32	1.11	1.20	1.48
Economics	1.20	1.45	1.25	0.0	1.45

* Includes engineering schools from cells 5 & 6.

Table B-3 Weighted Number of Departments and Faculty, by Control and Top 50 Status of Institutions*

Departments	All		Public		Private		Top 50		Other	
	Dept.	Faculty	Dept.	Faculty	Dept.	Faculty	Dept.	Faculty	Dept.	Faculty
Electrical Engineering	125	3,473	85	2,313	40	1,159	42	1,781	83	1,692
Mechanical Engineering	120	2,654	81	1,891	39	763	40	998	80	1,656
Metallurgical/Materials Engineering	72	1,029	48	681	24	348	30	481	42	548
Atmospheric Sciences	48	839	37	713	11	126	25	395	23	444
Geosciences	105	2,110	72	1,528	33	582	43	1,054	62	1,056
Cell Biology	138	4,584	89	3,189	49	1,396	45	1,818	93	2,766
Mathematics/Applied Math	144	5,236	97	3,969	47	1,268	46	2,332	98	2,904
Chemistry	165	5,534	111	3,803	54	1,730	46	2,606	119	2,928
Physics	145	4,960	94	3,449	51	1,511	46	2,239	99	2,721
Economics	124	3,069	82	2,096	42	973	45	1,456	79	1,513
Total	1,186	33,488	796	23,632	390	9,856	408	15,160	778	18,328

* Totals may not add due to rounding involved in weighting process

Comparison of Respondents and Nonrespondents

Departmental response rates varied from a high of 82 percent (chemistry) to a low of 63 percent (atmospheric sciences). With minor exceptions, departments in public institutions were somewhat more likely to respond to the survey than were departments in private institutions (see Table B-4). Further, departments in the top 50 institutions were less likely to respond than were those in other institutions. The only exception was departments of atmospheric sciences where more of those located in the top 50 institutions than in others responded to the survey.

Table B-4. Departmental Response Rated by Control and Top 50 Status of Institutions (In Percentages)

Departments	Total	Public	Private	Top 50	Other
Electrical Engineering	76.0	78.8	70.0	66.7	80.7
Mechanical Engineering	75.8	74.1	79.5	70.0	78.8
Metallurgical/Materials Engineering	69 4	72.9	62.5	60.0	76.2
Atmospheric Sciences	62.5	67.6	45.5	68.0	56.5
Geosciences	74.3	79.2	63.6	67.4	79.0
Cell Biology	74.[illegible]	71.9	79.6	66.7	78.5
Mathematics/Applied Math	80.6	84.5	72.3	71.7	84.7
Chemistry	81.8	81.1	83.3	71.7	85.7
Physics	77.9	78.7	76.5	67.4	82.8
Economics	78.2	82.9	69.0	68.9	83.5

Other Reports of the Higher Education Panel
American Council on Education

Gomberg, Irene L. and Atelsek, Frank J. **International Scientific Activities at Selected Institutions, 1975-76 and 1976-77.** Higher Education Panel Report, No. 37, January, 1978

Atelsek, Frank J. and Gomberg, Irene L. **New Full-Time Faculty 1976-77: Hiring Patterns by Field and Educational Attainment.** Higher Education Panel Report, No. 38, March, 1978

Gomberg, Irene L. and Atelsek, Frank J. **Nontenure-Track Science Personnel: Opportunities for Independent Research.** Higher Education Panel Report, No. 39, September, 1978

Atelsek, Frank J. and Gomberg, Irene L. **Scientific and Technical Cooperation with Developing Countries, 1977-78.** Higher Education Panel Report, No. 40, August, 1978

Atelsek, Frank J. and Gomberg, Irene L. **Special Programs for Female and Minority Graduate Students.** Higher Education Panel Report, No. 41, November, 1978

Gomberg, Irene L. and Atelsek, Frank J. **The Institutional Share of Undergraduate Financial Assistance, 1976-77.** Higher Education Panel Report, No. 42, May, 1979

Atelsek, Frank J. and Gomberg, Irene L. **Young Doctoral Faculty in Science and Engineering: Trends in Composition and Research Activity.** Higher Education Panel Report, No. 43, February, 1979

Atelsek, Frank J. and Gomberg, Irene L. **Shared Use of Scientific Equipment at Colleges and Universities, Fall 1978.** Higher Education Panel Report, No. 44, November, 1979

Gomberg, Irene L. and Atelsek, Frank J. **Newly Qualified Elementary and Secondary School Teachers, 1977-78 and 1978-79.** Higher Education Panel Report, No. 45, February, 1980

Atelsek, Frank J. and Gomberg, Irene L. **Refund Policies and Practices of Colleges and Universities.** Higher Education Panel Report, No. 46, February, 1980

Gomberg, Irene L. and Atelsek, Frank J. **Expenditures for Scientific Research Equipment at Ph.D.-Granting Institutions, FY 1978.** Higher Education Panel Report, No. 47, March, 1980

Atelsek, Frank J. and Gomberg, Irene L. **Tenure Practices at Four-Year Colleges and Universities.** Higher Education Panel Report, No. 48, July, 1980

Gomberg, Irene L. and Atelsek, Frank J. **Trends in Financial Indicators of Colleges and Universities.** Higher Education Panel Report, No. 49, April, 1981

Atelsek, Frank J. and Gomberg, Irene L. **An Analysis of Travel by Academic Scientists and Engineers to International Scientific Meetings in 1979-80.** Higher Education Panel Report, No. 50, February, 1981

Atelsek, Frank J. and Gomberg, Irene L. **Selected Characteristics of Full-Time Humanities Faculty, Fall 1979.** Higher Education Panel Report, No. 51, August, 1981

Atelsek, Frank J. and Gomberg, Irene L. **Recruitment and Retention of Full-Time Engineering Faculty, Fall 1980.** Higher Education Panel Report, No. 52, October, 1981

Andersen, Charles J. and Atelsek, Frank J. **Sabbatical and Research Leaves in Colleges and Universities.** Higher Education Panel Report, No. 53, February, 1982

Atelsek, Frank J. and Andersen, Charles J. **Undergraduate Student Credit Hours in Science, Engineering, and the Humanities, Fall 1980.** Higher Education Panel Report, No. 54, June, 1982

Andersen, Charles J. and Atelsek, Frank J. **An Assessment of College Student Housing and Physical Plant.** Higher Education Panel Report, No. 55, October, 1982

Gomberg, Irene L. and Atelsek, Frank J. **Financial Support for the Humanities: A Special Methodological Report.** Higher Education Panel Report, No. 56, January, 1983

Gomberg, Irene L. and Atelsek, Frank J. **Neuroscience Personnel and Training.** Higher Education Panel Report, No. 57, June, 1983

Atelsek, Frank J. **Student Quality in the Sciences and Engineering: Opinions of Senior Academic Officials.** Higher Education Panel Report, No. 58, February, 1984

Andersen, Charles J. **Student Quality in the Humanities: Opinions of Senior Academic Officials.** Higher Education Panel Report, No. 59, February, 1984

Andersen, Charles J. **Financial Aid For Full-Time Undergraduates.** Higher Education Panel Report, No. 60, April, 1984

Gomberg, Irene L. and Atelsek, Frank J. **Full-time Humanities Faculty, Fall 1982.** Higher Education Panel Report No. 61, August 1984

Andersen, Charles J. **Plant Biology Personnel and Training at Doctorate-granting Institutions.** Higher Education Panel Report, No. 62, November, 1984

Andersen, Charles J. **Conditions Affecting College and University Financial Strength.** Higher Education Panel Report No. 63, October 1985

Holmstrom, Engin Inel and Petrovich, Janice **Engineering Programs in Emerging Areas, 1983-84.** Higher Education Panel Report No. 64, November 1985

El-Khawas, Elaine **Campus Trends, 1984.** Higher Education Panel Report No. 65, February, 1985

Suniewick, Nancy and El-Khawas, Elaine **General Education Requirements in the Humanities.** Higher Education Panel Report No. 66, October 1985

Holmstrom, Engin Inel, **Recent Changes in Teacher Education Programs.** Higher Education Panel Report No. 67, November 1985

Andersen, Charles J. **Student Financial Aid to Full-time Undergraduates, Fall 1984.** Higher Education Panel Report No. 68, January 1986